ANCIENT SKIES

"Come Search With Us!"

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PLANETS BEYOND OUR SOLAR SYSTEM

BY DR PHILIP A. IANNA*

Centuries ago a few independent thinkers contemplated the heavens and saw that the myriad stars were like our own sun They reasoned from analogy with the earth that there must be other worlds and other living and intelligent creatures The Roman philosopher and poet, Lucretius, wrote:

> "It is in the highest degree unlikely that this earth and sky is the only one to have been created
>
> Nothing in the Universe is the only one of its kind, unique and solitary in its birth and growth
>
> You are bound therefore to acknowledge that in other regions there are other earths and various tribes of men and breeds of beasts "

Such radical views have not always been welcome The Dominican monk, Giordano Bruno, advocated a Copernican solar system with the earth revolving about the sun, and he argued for a universe filled with planets on which lived other beings After an eight year imprisonment he was burned at the stake

In more recent time, Percival Lowell characterized Mars as the "Abode of Life" and described a dying civilization desperately fighting to remain alive with the help of a vast network of canals We now know there are no canals and there is no evident civilization on Mars Nevertheless, interest in extraterrestrial life is more intense than ever Indeed, I can imagine no greater discovery than of other intelligent beings Nothing else will ever have such a profound and everlasting impact on terrestrial life

The scientific community today takes the "search for extrasolar planets and extraterrestrial intelligence" (SETI) very seriously Meetings of the International Astronautical Federation and the International Astronomical Union (IAU) have been devoted to a discussion of search strategies Both the US and the USSR Academies of Sciences endorsed SETI as a scientific priority NASA was finally authorized by the US Congress to spend 1 5 million dollars for SETI research In 1982, the IAU organized a new commission devoted to SETI The establishment of IAU Commission 51 recognizes that activities such as the search for planetary systems and radio signals from advanced civilizations are legitimate scientific endeavors

Indeed much effort is currently being directed to this problem The Hubble Space Telescope will provide observations from space in several modes to look for planets, and there will be other future spacecraft applied to the search Several astronomical observatories have programs underway designed to find other planets The detection of "extraterrestrial intelligence"(ETI) may be in some ways easier than finding distant planets If we can just listen at the right time to the right direction in space and with the right frequency we may find an interesting radio signal Complex receivers have been built for this purpose allowing the simultaneous scanning of 65,000 separate frequencies, and there are radio frequency analyzers now under construction having eight million channels In these cases the limitation is the speed at which a computer can analyze such a mass of incoming data to pick out an interesting signal

Current knowledge supports the existence of planetary systems around other stars Most astronomers believe we have at least a qualitatively correct description of the formation of stars and the origin of our solar system Considerable progress has been made with the computer simulation of star formation based on realistic models and recent observational data Stars are formed from condensing clouds of dense interstellar dust and gas initially a few light years across Slowly rotating clouds seem most likely to collapse into a single rather than multiple stars Dust in the outer regions of the collapsing cloud tends to form a flattened disk, then there must frequently be debris left over from this process to slowly accumulate into small cold lumps and finally into planets A few of the condensed planets may fall at distances from their central stars similar to the earth's distance from the sun A few of those may have had initial chemical compositions resembling those of the young earth, conducive to the formation of organic compounds and the eventual development of living organisms

Given some degree of likelihood that somewhere out there are planets and creatures - there are a few hundred thousand millions of stars in the Milky Way - can we estimate how many extraterrestrial (ET) civilizations might be there? Such educated guesses have been attempted through the so-called Greenbank or Drake formula The various multiplicative factors in the equation - the fraction of stars having planets, the fraction of those on which life forms, the fraction of those developing high technology, etc - lead to "N", an estimate for the number of advanced civilizations in the Galaxy The problem is knowing what numbers to put in

There is certainly not any sort of general agreement regarding the possible number of technological societies And it seems that almost anyone can be an expert - just pick a number between one and a million, any number For example, during one session devoted to this question at the IAU meeting in Montreal, Canada in August 1979, different presenters argued various values for N Since life tends to

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proliferate, Thomas Kuiper thought this number is probably very large Michael Hart argued for the opposite extreme, since if there were many galactic civilizations they should be here by now, and they do not seem to be Some of his other work provides part of his reasoning He has modeled the evolution of the earth's atmosphere by computer, and his results show the zones surrounding stars at distances favorable to the development of inhabited planets are much narrower than previously thought; a few percent change in a planet's location leads either to permanent glaciation or runaway greenhouse effect, so planets favorable to life would be rare Frank Drake supported the view that N is neither very large nor very small on economic grounds, that is, the spread of technological societies would be restricted, because interstellar travel would be prohibitively expensive; and Michael Papagiannis thought N would be either very large or very small

So N can be any number you like, and chosen for different and apparently plausible reasons This illustrates the range of speculation possible where there is almost no evidence to constrain the argument Nevertheless, guessing at the number of advanced technical civilizations is not a totally silly exercise, it just seems that way because we have so little information Thinking about the question has some practical value: the influential factors suggest some places to look for life, that is, around stable, single, sun-like stars, and the increased visibility of the whole matter is of political benefit Hopefully the necessary financial support will follow, and eventually the scientific discoveries as well

Indeed, what we really want to have is solid, incontrovertible evidence of other planetary systems and ETI There are three major areas in which these exciting results can be established: 1) evidence of past visitation, 2) the presence on earth today of ETI's, or 3) detection from earth of other planets, in particular those with technological societies, either directly or through communications

The Ancient Astronaut Hypothesis of Erich von Daniken and others proposes visitations in the remote past by intelligent beings from outer space If we could find some item of undeniably more technical sophistication than indicated by the archaeological context of its discovery, we would have quite an interesting case for ancient astronauts What we have to date are stone monuments, gold artifacts, and legends of sky gods,collectively interesting, but not convincing This is not saying the evidence cannot be there, because it could; nor is it saying we should not look, because someone should

The dearth of alien visitors does indeed bring to mind the questions "Where are they?" and "Are we alone?" One problem is, assuming no evidence of visits for the moment, you can estimate that, if N is large, the Galaxy could be widely explored and colonized in 10 million years or so - a fraction of the 10 thousand million year age for the Galaxy If "they" were there, they should have been here by now Of course a rejoinder to that is perhaps they have been, found only algae growing on earth two billion years ago, and resumed their journey

Some other difficulties suggest N may be small For example, single stars with planets may be very rare indeed Perhaps 80-95% of all stars are double or multiple, making it difficult to have stable planetary orbits An even smaller fraction of any single stars may not have planets at the right distance As mentioned, Michael Hart's results indicate the surrounding zones about stars favorable to the development of inhabited planets and advanced civilizations are much narrower than thought before

But to go back a step before the question about the ubiquity of habitable planets, it would be nice to know just how frequent planetary systems really are Does every single star like the sun have planets, or only one in a hundred? Although the story could change at any moment, at this moment, we have no good evidence there is even one single additional planet anywhere beyond the solar system There are several possible cases, yes, but clear positive evidence of any other planets, no

Owing to the contrast between a faint planet and the bright star to which it would be attached, there is little hope of seeing planets around even the nearest stars from the surface of the earth by conventional optical means It is a bit like trying to see a mosquito buzzing around a bright street light from one kilometer away Further, turbulence in the earth's atmosphere blurs and blends star images severely degrading a telescope's resolution for photographic or visual observations Perhaps the Space Telescope will be able to observe such planets, but until then we will continue to have to resort to indirect means of detection, and/or new observational techniques

One particularly fruitful approach depends on the precision measurement of a star's track across the sky The gravitational influence of stellar companions or planets results in a "wobble" in what otherwise would be motion in a straight line The companion to Sirius was first suspected in this manner a hundred years ago, then confirmed visually In general the effect is exceedingly delicate and the greatest care is required to sense such a perturbation When we have ten years of data and hundreds of photographs of the star field and can measure the locations of the star images to an accuracy of 0 001 mm we can plot the path of the star well enough to detect the small deviations that may indicate the presence of a very low mass companion star or planet Such astrometric measurements have detected small companions for about 30 nearby stars

An analogous program is being carried out with the Mt Wilson 100-inch reflecting telescope where Geoffry Marcy is looking for small periodic shifts in the radial velocity component caused by orbital motion Since velocity changes as small as 250 meters per second can be observed, an object of 5-10 Jupiter masses could be detected around a nearby low-mass cool dwarf star About 50 stars are under scrutiny

The most widely publicized astrometric case is that of the second nearest star, Barnard's star A massive amount of data from the Sproul Observatory has been analyzed and re-analyzed and problematic instrumental errors corrected According to P van de Kamp the data are evidence for the presence of two Jupiter-sized planetary companions The low amplitude of the perturbation, and the uncertainty of the telescope's stability lead to a wish for independent confirmation Data from the McCormick Observatory has also been tracking this star with their 61-inch reflector The latest word from there seems to be negative, no clear evidence for perturbation, although earlier they had been reporting at least a suggestive trend in their positional data

One of the difficulties with this technique is that the analysis of such a perturbation can give only a lower limit to the mass of the companion Imagine for a moment two stars of equal mass and brightness They swing together around their center of mass like two dancers firmly locked in a gravitational embrace The image we record is the blend of these two images As the two stars whirl about one another the apparent position of their blended images does not change, and there is no detectable perturbation Now imagine one of the stars to be just slightly fainter and of slightly lower mass As their orientation changes in the sky, the location of the blended image moves with the period of revolution and we might be able to measure the perturbation But there is a problem A companion of very small mass produces a small perturbation, but a companion close to the size of the primary star also produces a small perturbation So we really

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need some direct indication of the brightness difference of the two stars to correctly interpret the astrometric observations

Infrared speckle interferometry is a recently developed direct imaging technique showing considerable promise as a means of detecting faint stellar companions The analysis is complicated, but it enables the full resolution of a telescope to be achieved, as if there were perfect images unaffected by the atmosphere Thus two stars with the same separation as the earth from the sun could be seen even if they were 50 light years away

The highly magnified image of a star viewed through a telescope has a "grainy" structure that changes very rapidly This speckle pattern can be photographed if the exposure is short enough, something like 1/100 second The speckles are a consequence of interference between light rays that have been distorted by atmospheric turbulence, travel different paths thru the telescope, but then arrive together at a particular point in the image Because the information in the speckle comes from points over the full telescope aperture, detail can be as good as the theoretical resolution limit of the telescope, a few hundredths of an arcsec for a large telescope In the analysis many speckle patterns are combined to reconstruct the star image Many remarkable results have come from speckle interferometry in the last decade, including the measuring of very close binary stars and resolving the true disks of several stars

Some especially promising results have come from the infrared speckle observations of D McCarthy at Steward Observatory The advantage of infrared in this instance is the increased brightness at these thermal wavelengths (around 2 microns) of astronomically very cool stars with surface temperature of only two or three thousand degrees Kelvin (degrees Celsius above absolute zero) Primary targets for this program have been some of the nearby stars showing perturbations in their paths It has been re-assuring to see the companions to many of the previously unresolved binaries But companions have not yet been seen in a number of cases In particular no companions have been detected for Barnard's star, meaning a quite dark companion or no companion at all

The most exciting recent announcement has been the detection of a companion, and possible planet, for van Biesbroeck 8 (VB8) A tentative suggestion of a perturbation was made for Naval Observatory data by R Harrington, V Kallarakal and C Dahn in July 1983 The authors wrote "It seems reasonably clear that there is a significant nonlinear trend an entire period of the perturbation has yet to be observed making interpretation almost impossible " The interpretation has now been aided by several speckle observations The detection of the faint companion by McCarthy, along with colleagues R Probst and F Low, has been called by them "the first direct detection of an extra-solar planet " Their observations place the surface temperature of the companion, VB8B, at 1360 degrees K and they estimate the mass to be from 30 to 80 Jupiter masses, however the orbital period is not yet known, so the mass estimate is subject to revision The object is almost certainly substellar, that is, not massive enough to trigger the normal stellar thermonuclear energy-generating processes, but it does not fit the common notion of what is meant by a "planet " It is also being called a "brown dwarf", a term that has been used in previous theoretical discussions of such substellar objects This now makes VB8 part of a sextuple star system with two other binaries, designated Wolf 629 and Wolf 630

Infrared observations are difficult to carry out from the surface of the earth owing to the atmosphere - it is not very transparent at most infrared wavelengths - forcing limited wavelength coverage even from high altitude observatories and the infrared telescopes flown in aircraft To extend such observations, in the early part of 1983 the Infrared Astronomical Satellite (IRAS) was launched with a detector system about 90 times more sensitive to the infrared radiation of dust and cool stars than any previous IR observations from space This Dutch-built satellite with a US telescope controlled from the United Kingdom was expected to produce results relevant to a range of astronomical problems including the birthrate of stars in our Milky Way Galaxy

Within a few months, IRAS discovered what was called "the first direct evidence that solid objects of substantial size exist around a star other than the sun " As such things often are, this was to some extent an accidental encounter The observations of the star Vega, one of the brightest stars in the sky, were planned because Vega is a frequently used calibration source When the excess IR emissions were found, the satellite was used to scan the area around the star, finding material with a temperature of 88 degrees K extending over a region about twice the size of our solar system The particles were at first estimated to be a few millimeters in size, since finer dust would be blown away by the star's radiation, but subsequent observations have suggested they are about 10 times smaller with a total of only about one percent of the earth's mass This does not rule out the presence of large objects

Then a second star, Fomalhaut, was found to be engulfed in similar material, small solid grains warmed by the star Fomalhaut is also a bright star, rather hotter than the sun, and at a distance of about 22 light years Again the IRAS observations only show the material to be in the vicinity of the star, and do not tell us if there are planet-sized chunks there

Another limitation to the IRAS observations is that,although IRAS could see the cool dust surrounding these stars, it was not possible to describe the distribution of the material, that is, was the dust spread throughout a sphere, or confined to a flat disk and so resembling a planetary system Now, recent observations of Beta Pictoris, a star about 50 light years away and also observed by IRAS, show it to be embedded in a disk The elongated image of the disk was obtained by B Smith and R Terrile at the Las Campanas Observatory by masking out the bright image of Beta Pictoris during the observation and also subtracting the scattered light around the star In their picture the dust can be traced out to about ten times the size of the solar system The material is thought not to extend all the way to the star, but to have a central void about the size of the solar system Although again not enough evidence for planets, it is a direct observation of exactly the sort of protoplanetary disk out of which planets are expected to form With such disks seen about other stars, can planets be far behind?

These are exciting times in the quest for extra-solar planetary systems A wide variety of ground-based and space-based research programs have found and investigated disks of dust around other stars and dim substellar companions These observations are tantalizingly close to the actual discovery of planets like those of the solar system elsewhere in the universe Hopefully we will not have to wait much longer.

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AN INVITATION TO EXPLORE

BY ANDREW TOMAS*

How did man appear on our planet? When was civilization born? To those who think that answers to these questions can be found easily in textbooks on anthropology and history, I throw a tiny morsel of information which is gigantic in its implication It is this: the total load of bones, skulls and bone fragments of early man, discovered all over the globe would barely fill a small truck (1) With only a limited amount of prehistoric evidence to work with, one can speculate a little and attempt to fill in the missing gaps in the story of mankind

The history of civilization has an equally acute shortage of source data, but we know how this has occurred If the Alexandrian Library with its over 700,000 papyri had not been destroyed by Bishop Theophilus and his Christian fanatics in 391 AD, the history of antiquity would then appear before our eyes in a true light

This situation creates a challenge to restore the patterns of bygone epochs and to find the lost pages from the Book of Time The history of the human race is a continuous battle for knowledge When man no longer evidences interest or curiosity, he is no longer man It was Euripides (5th Century BC) who described this craving for knowledge:

"Happy is the man who has experienced
The joys of untrameled search after knowledge,
Pensively he watches the never-aging structure
of eternal Nature,
Asking why it arose and whence and how "

One of the tantalizing problems of science is the question how man appeared on earth, became master over the giant mammoth and powerful auroch, and survived the frost of the Ice Age? An even greater puzzle is the arrival of a primitive civilization among the Cro-Magnon tribes some 35,000 years ago

For thousands of years the intelligent Cro-Magnon was paving the way for future civilizations He kept a lunar calendar by means of notations on bones (2) Aurignacian markings on pebbles and bones from Mas d'Azil in France might have been man's first experiment in writing

The cave paintings and carvings of Lascaux and Altamira, depicting bisons, mammoth and other animals in a realistic yet highly artistic style, remind one of the sketches of Picasso

The biography of the Cro-Magnon merges into that of the early Sumerian, Egyptian, Greek and European From about 15,000 BC to 6,000 BC a lot of things must have happened to give birth to history as we know it

Unfortunately, except for the casual remarks made by writers of antiquity, or the fabulous tales of mythology, hardly anything remains to tell us what actually took place in prehistory

It may thus be wise to listen to what the ancient Egyptians, Greeks and Babylonians have to say in regard to the coming of the gods from the sky who became the teachers of mankind

The sudden appearance of civilization in antiquity has been noted by a number of historians Kenneth Clark, for instance, made a remarkable statement in one of his television programs entitled "In the Beginning - the Mystery of Ancient Egypt:"

"Civilization seems to have appeared with the suddenness of a sunrise in the Nile Valley between 3,000 and 2,800 BC It was as though, after half a million years of semi-conscious existence, man leaped into full awareness of himself and his surroundings in the course of about 200 years "(3)

Today not all historians reject the value of mythology as a source of history The French savant, Rene Sedillot, in his History of the World, boldly states that:

"These ancient myths are a confusion of gods and mortals They raise men to heaven and bring down gods to earth They attribute a divine origin to such things as the invention of fire and iron, the making of the plow, the finding of the vine, the revelations of language, the founding of races and cities Compared with these grandiose imaginings science is poor It has neither gods nor epic deeds to offer "

What do ancient sources and myths say about the early beginnings of history? They all mention the descent of god-like beings on fiery serpents, dragons and birds They all speak of the wonderful arts and crafts the gods taught, making man's life easier, more interesting and enlightened. That era of the gods is still remembered as the Golden Age

Many myths are echoes of history The ancient Greeks were the creators of logic and philosophy and also of rich mythology The myth of the Argonauts describes Dioscuria, the city of the legendary twins Dioscuri - Castor and Pollux Although Strabo and other classical writers stated that it was located in the Caucasus, Dioscuria eventually disappeared from ancient maps and turned into a legend Nevertheless, Dioscuria became a reality in the 1950s when Soviet archaeologists discovered its stonework and statues under water off Sukhumi in the Black Sea

Where does history and fact cease and myth and fable begin? Can legend become reality?

(1) Archaeology, Dr F Celoria, London, 1970.
(2) The Roots of Civilization, Dr A Marschack, London, 1972
(3) Readers Digest, June 1975

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THE CASE FOR CLEVER-CRAZY IDEAS

BY PAUL NEY*

The Ancient Astronaut Theory needs much scientific support and methodology to further a permanent discussion of its concepts So I greet the open letter of Dr Vladimir Rubtsov in Ancient Skies 11:4 and his approach

While science and its standards should be kept intact, let us not forget that science fiction plays an educational role as well as provides a means to develop fantasy Further, amateur scientists have produced some valuable results and have invested private fortunes for the advancement of scientific knowledge - witness Heinrich Schliemann

Scientific development is not always smooth Many times in history the "crazy" idea of a (para-) scientist has proved to be a clever one that led to a scientific revolution Thus, one must seriously reflect on the question: what does the scientific community need in order to accept "more easily" the "clever-crazy" ideas of the non-scientist? Science must investigate its own methodology and produce an adequate framework within its system for the consideration of new ideas, from whatever source

There is now a special interest group of scientists who support the ancient astronaut theory who can work voluntarily in an organized and recognized way to investigate new ideas within a structured system of study Computers can be used to great advantage in the analysis of data in order to apply a scientific system of evaluating the data provided by amateurs

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